

APPLICATION OF DRONES IN PROTECTION OF STATE BORDER

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Abstract

An unmanned aerial vehicle is a flying apparatus that does not require a crewmember on board to complete a task. Its piloting is done by means of indirect control. UAVs also have the ability to perform autonomous flight on a pre-programmed flight path. The purpose of the study was to use the unmanned aircraft "Fly Eye" by WB Electronic used by the Border Guard to patrol the state border in 103 TRA zone on the section of the Republic of Poland with the Kaliningrad District of the Russian Federation. The TRA zones constitute a specially designated area for the use of the Border Guard and the army, in order to carry out flights there beyond the scope of the pattern for training purposes and to patrol the state border. The article also contains information of the Border Guard formation and the characteristics of the unmanned aerial vehicle "FlyEye". In order to ensure the safety of the UAV flight, the test was carried out in the TRA zone, which is used for special use for the Border Guard formation and the army.

Keywords: *Unmanned Aerial Vehicles, Flying Platform, Drone, Unmanned, UAV, Unmanned Aerial Vehicle, Fly Eye, Border Guard, Operator*

1 Introduction

The interest in unmanned aerial camera technology has been growing over the years. The potential of the Unmanned Aerial Vehicle (UAV) application is visible in every area of life. Drones are used by both scientists, uniformed formations and civil services [8].

Along with the technological development of UAV, aviation law is developing dynamically, which is conditioned, among other things, by a large number of accidents and understatements related to this branch of avionics. In Poland, aviation law determines the possibilities of flying drones independently for civilians and for state services. These services are in possession of specially designated zones (e.g. TRA zones), which they can dispose of and move within them after prior arrangement with PANSZA (Polish Air Navigation Services Agency).

The operator is responsible for the preparation and operation of the UAV. Before the flight, he is required to program the flight path and the landing site for an autonomous flight. He also inspects the technical condition of the machine by performing a pre-start inspection [2].

2 Border Guard

The Border Guard is a uniformed and armed formation. Its objectives are to protect the state border in the area of land and sea, as well as border traffic control. The protection of the state border is to ensure the security of the country. The key task of the Border Guard is to protect the state border and to conduct border traffic control. Formation of the Border Guard is responsible for issuing authorizations for crossing the state border and visas. The role of the recognition and detection of crimes and offenses is in this area. For these offenses, the Border Guard is obliged to start prosecuting their perpetrators and, above all, all crimes and offenses relating to crossing the state border. Another instruction is also to check the credibility of the documents required to cross

the border. The tasks of the Border Guard are also ensuring security in communication at the border and controlling the order at the border crossing [4, 5, 7].

2.1 „FlyEye” Specification

“FlyEye” is an unmanned medium-range aircraft taking off from the operator's hands. The control takes place autonomously after the planned flight route. The software allows changing the control to manual. The operator may commission site observations beyond the remote control capabilities, and the UAV will return alone to the location indicated above. The autopilot, which takes into account the direction and strength of the wind itself, calculates the glide path, thanks to which the landing takes place autonomously with an accuracy of up to 10 meters. Before landing, the unmanned drone dumps a head and batteries with a parachute. The UAV software provides a constant view of the machine's position on the digital map [3]. In the event of loss of communication it is programmed to take off into the air, if communication is still unavailable, the device returns to the last communication place. If none of the actions helps to establish a connection, the UAV returns to the control station. They are used by the Border Guard during actions to prevent illegal migration and to fight smuggling [1].

Tab. 1 „FlyEye” Technical Data [1]

Wingspan	3.9 m
Length	1.9 m
Structure	Composite
Take Off weight	11 kg
Payload weight	2 kg
Propulsion	Electric Engine
Pitch	4 km
Operating Range	15 km
Velocity	50-170 km/h
Required starting area	30x30 m
Required landing area	100x100 m
Maximum flight time	4 h
Maximum wind speed	17 m/s
Temperature operating range	-10°C do +50°C

3 TRA Zones

The length of the state border on the section of the official responsibility of the Warmian-Masurian Border Guard Department is almost 200 km long. SG officers, while protecting the border, pay special attention to places that are convenient to cross the border. This task is used, among others, unmanned aerial vehicles flying in zones TRA 100-107.

Polish Air Navigation Services Agency in March 31 of 2016 established TRA zones for unmanned aerial flights carried out of sight for the needs of the Border Guard to protect the state border. These areas have been made public in the AUP (Airspace Use Plan) by AMC Poland. Thanks to the TRA zones, Border guards are exempted from the order to identify, submit the FPL and maintain constant communication with the ATS unit in the ADIZ (Air Defence Identification Zone). Before the UAV inlet from the FIS zones to the TRA, the Border Guard is obliged to activate

the zone one hour before the planned flight. In the case of such a notification, other users of the TRA zone are obliged to leave the indicated zone and inform the FIS about leaving the area [8].

The TRA100 – TRA130 zone, established for the protection of the state border, runs along the state border of the Republic of Poland; on the northern border with the Kaliningrad District of the Russian Federation, north-eastern Lithuania and eastern with Belarus and Ukraine. These zones extend into the territory of our country to a distance of about 15 km.

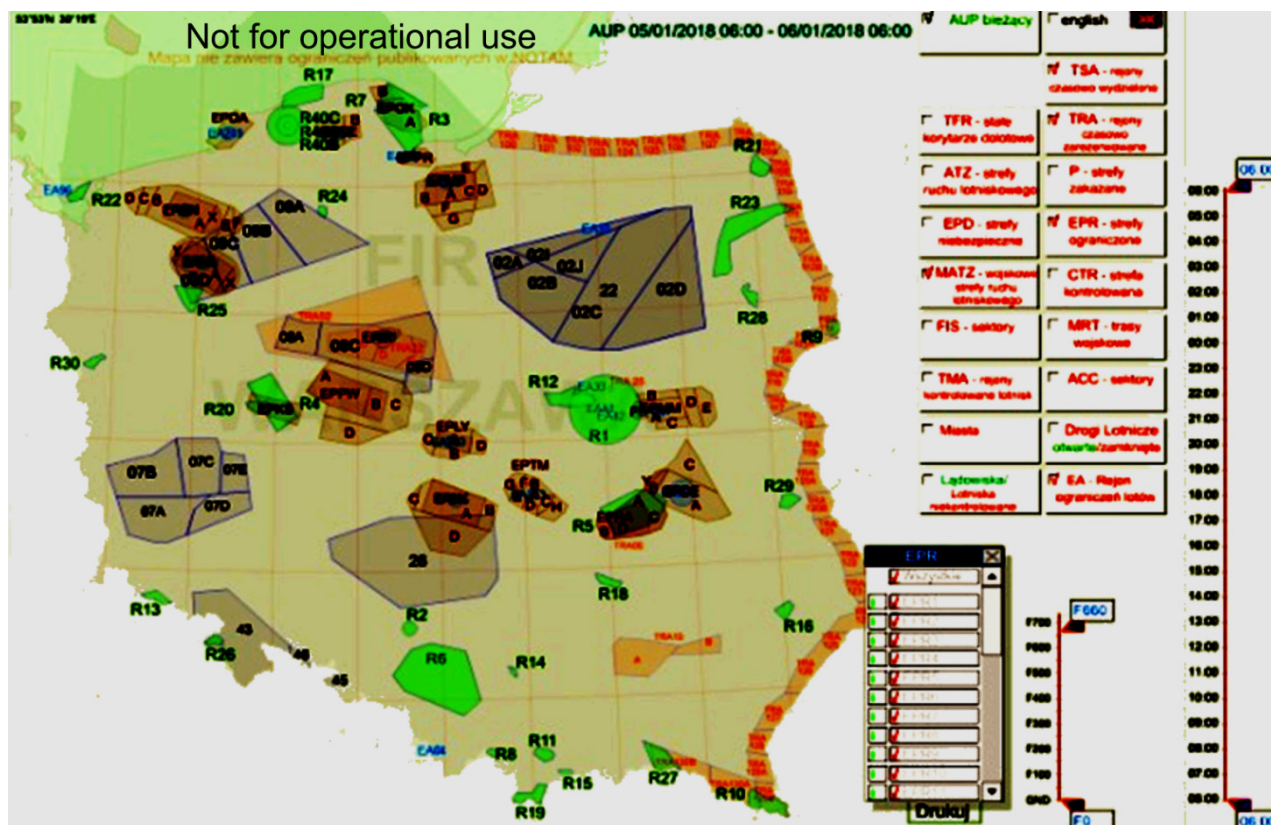


Fig. 1. AUP Current TRA Zones [8]

3.1 Rules in the activated TRA zone for the needs of border guards

After activating the TRA zone, another airspace user should not get permission for flights in the active zone. However, there are some exceptions to this rule, and TRA users are subject to the following restrictions:

1. Flights in the TSA zone have priority over flights in zones TRA 100-104.
2. Flights in TRA may be performed simultaneously with TSA flights upon agreement by AMC Poland, however, provided that the horizontal distance of not less than 3.5 NM from the limits of the active zone of another user or with a vertical distance of 500 ft is maintained.
3. AMC Poland may set priorities for other types of flights in relation to UAV flights, e.g. fox vaccine injection.
4. The FIS informer, after receiving notification by the crew of the aircraft about the need to travel through the active TRA zone, consults the UAV operator about the possibility of such a trip.
5. FIS or AMC Poland may also suspend, interrupt or change the UAV's flight conditions for example in the case of search and rescue flights, firefighting, providing assistance in cases of threats to health or life of people and animals, and in particular the occurrence of natural disasters, catastrophes, threats or emergency situations.

Coordination of flights in the TRA zones from the Border Guard level takes place via the Operational Duty Service. The TRA zones are activated at AMC Poland reporting the need for flights in good time before the planned use of the TRA zone [8].

4 Research area

The subject of the research is the flight parameters carried out in the airspace in the TRA 103 zone – the area of the official responsibility of the Border Guard Post in Sępólno. The section of the protected state border measures over 22 km there, from the east from the border sign No. 2225 to No. 2272. The service area is located in the Sępólno lowland, which is crossed by the Łyna River – the largest of the northeastern Polish rivers. This river crosses the borderline and passes to the side of the Russian Federation between border signs No. 2253 – 2252. The area is lowland with plains dominating and is slightly hilly, to a small extent urbanized with a small percentage of forests.



Fig. 2. Research area. Source: own study



Fig. 3. Area of the official responsibility of SG in Sępólno; source: Warmia-Mazury OSG

On 16th January 2018 officers of the Department of Security of Activities in the structure of which UAV operators at about 10:00 am activated the TRA-103 zone on the section of the SG Branch in Sępopol in order to carry out flights in the border area.

Pre-start procedures started before 12.00. On the flight plan, the starting point is marked, which the place of the future landing is at the same time. Both the plan and the landing site during the mission can be modified.

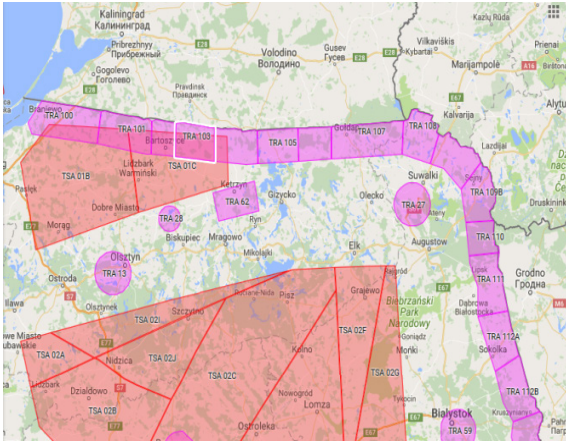


Fig. 4. Activated Zone TRA-103; source: own study

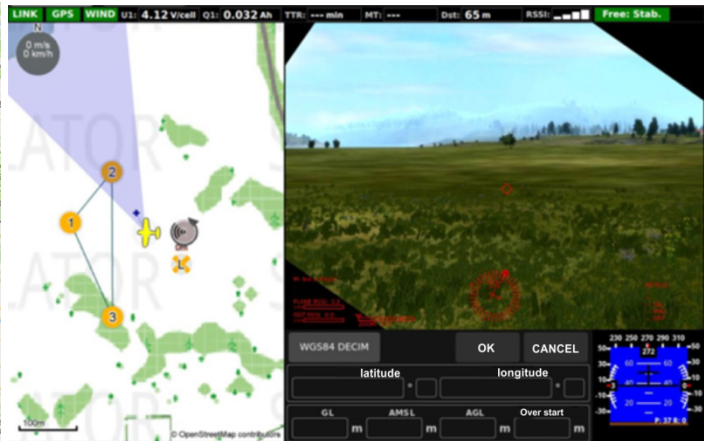


Fig. 5. „Pre-Start” Procedures; source: Warmia-Mazury OSG

Time: 12:14 “Pre-start procedure”. The flight plan is visible on the map. The aircraft will move between specific points 1, 2, 3 – “looping the plan” The camera is set in day mode towards the right wing. A speed of 70 km/h was set for a flight height of 100 m.

4.1 „Fly Eye” Flight



Fig. 6. Flight in „Flight Plan” Mode; source: Warmia-Mazury OSG



Fig. 7. Flight in „Flight Plan” Mode; source: Warmia-Mazury OSG

Time: 12:28 flight in “Flight Plan” mode. The map shows the changed flight plan defined by points 1, 2, 3 determined between the banks of the Łyna River. The plane moves towards point 2 (marked with a fillet colour). Daytime camera was directed to the riverbank. The flight speed is 69 km/h. Flight altitude 352 m. Wind power 5 m/s, 18 km/h with the direction of 236°.

Time: 12:30 flight in “Flight Plan” mode. Another plan near the border road was set in “plan looping” mode. The camera in night mode – thermovision, is directed to the area behind the road. Flight at 102 km/h is from the Łyna River towards the road. Flight altitude 409 m. Ground speed 118 km/h, altitude to sea level 536 m, descent -6.5 m/s.

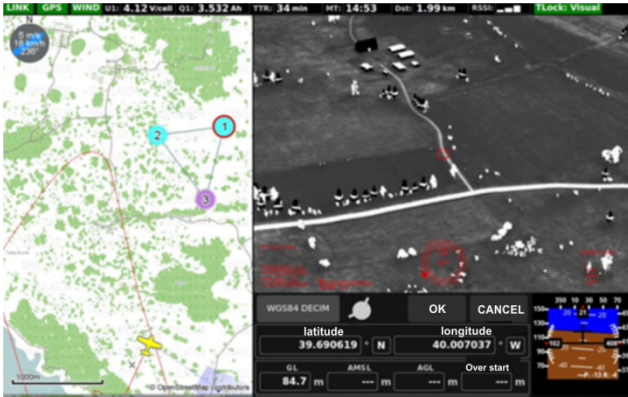


Fig. 8. Flight in „Camera Guide” Mode;
source: Warmia-Mazury OSG



Fig. 9. Flight in „Manual” Mode; source:
Warmia-Mazury OSG

Time: 12:31 flight in the “Camera Guide” mode (flight in the direction of the camera observation). The remaining flight time to the exhausted battery is 32 minutes. The ship follows the observed object (forest animal) located behind the border road. The flight at a speed of 70 km/h, at a flight altitude of 446 m, the descent is -1.4 m/s.

Time: 12:32 flight in “Manual” mode (platform control is done manually). The remaining flight time to exhausted battery is respectively 32 min. The plane flies at a speed of 70 km/h, altitude 389 m.



Fig. 10. Flight in „Flight Plan” Mode;
source: Warmia-Mazury OSG

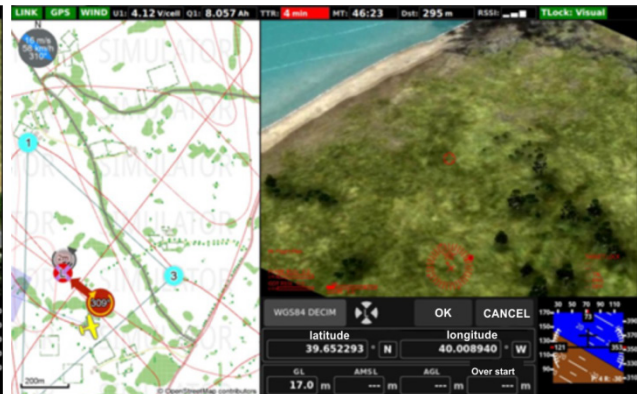


Fig. 11. Flight in „Landing” Mode; source:
Warmia-Mazury OSG

Time: 12:39 flight in “Flight Plan” mode using the Target Lock function (automatic tracking of the camera behind the observed object). The camera in day mode is directed to the vehicle moving along the road. Flight at 69 km/h is at an altitude of 401 m.

Time: 13:02:08 flight in “Landing” mode (plane during the landing stage). The remaining flight time to exhausted battery is 4 minutes. Approach in the direction of 309° is with the right direction of circulation to drop the container. Camera in day mode. Flight altitude 352 m. The flight speed is 121 km/h. Wind power increased to 16 m/s, 58 km/h with a direction of 310°. Ground speed: 162 km/h, altitude 372 m, falling -4.9 m/s.

Time: 13:02:48 flight in “Landing” mode. One minute of flight left to the exhausted battery. The camera ends the recording of the image in day mode, in a moment the container will be dropped. The "fast descent" function is visible on the screen to reduce altitude when approaching landing. The flight speed is 64 km/h, but the speed relative to the ground is only 8 km/h because

the plane lands in the wind with a force of 58 km/h, sinking down to -5.5 m/s.

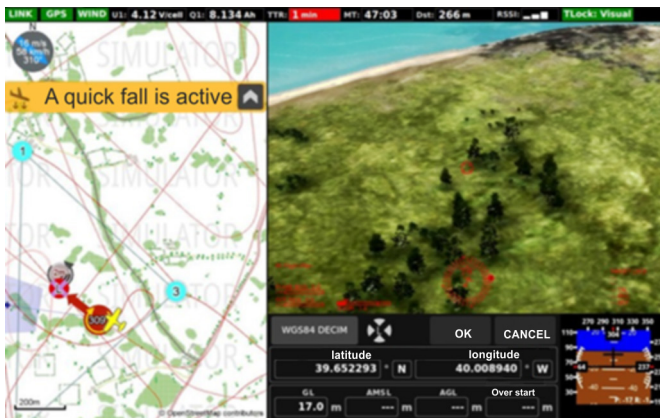


Fig. 12. Flight in „Landing” Mode; source: Warmia-Mazury OSG



Fig. 13. Landing with a parachute; source: Warmia-Mazury OSG

5 Summary

The study was designed to present the possibility of using unmanned aerial vehicles used by the Border Guard in the protection of the state border. On the basis of the conducted research, it can be stated that a team of 2-3 officers serving UAV together with patrols in the field can supervise a much larger area and control objects noticed or verify people in terms of their legality in this area, which will not be obtained by using vehicles and a secretive form of service on the border line. The appointment of the same number of officers moving vehicles will not limit the area of observation; however, the movement of official vehicles will indicate the presence of patrols in the field. However, in the case of a secretive service, the observation area with such a number of officers is significantly limited. The equipment of the Border Guard in unmanned aerial vehicles is a milestone in the possibilities of protecting the state border, which is of considerable importance on the external border of the European Union.

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